CLAIMS:

1. A method of producing an intensive flow of atoms from an input flow of a molecular gas with a source comprising a discharge cell connectable to a direct current source and defining at least one emitting aperture through which the flow is output from the cell, the method utilizing ignition of a gas discharge in said discharge cell and dissociation of the gas molecules by electron impact, and comprising:

providing ignition of the gas discharge of a complex type composed of a main discharge and two auxiliary discharges of different types ignited in substantially coinciding zones of the discharge cell, wherein

said main discharge is an arc Penning discharge ignited in a zone of the vicinity of said at least one emitting aperture,

the first auxiliary discharge is a magnetron discharge with heated cathode, and

the second auxiliary discharge is one of the following: a Penning discharge, and a Penning discharge with hollow cathode,

the dissociation of the gas molecules being thereby carried out in said complex discharge and resulting in creation of the flow of hot and thermally atoms.

2. The method according to Claim 1, wherein the density of the output flow is about 10^{13}-10^{16} cm^{-2} s^{-1}.

3. The method according to Claim 1, and also comprising the step of transition from the auxiliary Penning discharge with hollow cathode to the auxiliary Penning discharge without hollow cathode.

4. The method according to Claim 3, wherein said transition comprises changing a distance between the surface of a self-heating elongated electrode at least partly installed in a hollow electrode and the inner wall of said hollow electrode, thereby defining the possibility of plasma penetration into the hollow cathode.

5. The method according to Claim 1, and also comprising creation of a plasma jet emerging from the emitting aperture of the discharge cell, the dissociation of gas molecules being carried out in said plasma jet.

6. The method according to Claim 1, wherein the zone of main arc Penning discharge is characterized by a high density of fast electrons, and the zones of the auxiliary discharges are characterized by a radial decrease of the density of fast electrons.

7. The method according to Claim 1, wherein the flow of hot atoms is extracted from the zone of the main discharge.

8. The method according to Claim 1, wherein the flow of atoms is extracted from different radial locations of the zone of the auxiliary discharges.

9. The method according to Claim 1, wherein at least one atomic gas is used as a working gas, the extracted flow containing atoms excited to different energy levels by the electron bombardment.

10. The method according to Claim 1, and also comprising controlling the density of said output flow of atoms by varying the diameter of said at least one emitting aperture.

11. The method according to Claim 10, wherein said controlling of the output flow density comprises varying discharge current values.

12. The method according to Claim 10, wherein said controlling of the output flow density comprises varying gas flow rate values.

13. A source device for producing an intensive flow of atomic or excited particles, the device being connectable to a direct current source and comprising an electrodes' arrangement and a magnetic field source, wherein the electrodes' arrangement comprises a cylindrical anode and a multiple-electrode cathode which are axially aligned and define an inter-electrode space for a longitudinal magnetic field region, wherein

the multiple-electrode cathode comprises a first elongated self-heating electrode, a second flat reflective electrode in which at least one opening forming at least one emitting aperture is made, and a third reflective electrode the first electrode being electrically connected to the third electrode, when the device is put in operation;

the first self-heating elongated electrode is axially aligned with the cylindrical anode and penetrates into the anode cavity at a predetermined distance;

a butt-end of the first electrode located inside the anode cavity, a part of the surface of the second electrode opposite a butt-end of the first electrode and the cylindrical anode form a cell of a main arc Penning discharge ignitable in at least one zone in the vicinity of said at least one emitting aperture;

the first electrode and the cylindrical anode form a cell of a first auxiliary discharge, which is a magnetron discharge with heated cathode; and

the second and third reflective electrodes and the cylindrical anode form a cell of a second auxiliary discharge, which is one of the following: a Penning discharge, and a Penning discharge with hollow cathode.

14. The device according to Claim 13, wherein said third reflective electrode is a flat electrode located opposite to said second reflective electrode formed with the at least one emitting aperture, and comprises an opening through which the self-heating electrode is inserted into the anode cavity and which serves as an inlet for at least one molecular gas.

15. The device according to Claim 13, wherein that part of said first electrode, which is located inside the anode cavity, has a hollow cavity of a length equal to or slightly less than the height of the anode.

16. The device according to Claim 15, wherein said second auxiliary discharge is the Penning discharge.

17. The device according to Claim 15, wherein said first auxiliary discharge is the magnetron discharge with heated cathode.

18. The device according to Claim 15, wherein the main discharge is an arc Penning discharge with the self-heating hollow cathode.

19. The device according to Claim 15, wherein the emitting aperture is formed by the opening in said second electrode and an opening in the butt-end of the hollow cathode cavity opposite to said opening in the second electrode.

20. The device according to Claim 13, wherein said third reflective electrode has a hollow cavity located above said anode cavity, said first electrode extending along

the axis of the hollow cavity thereinside, with a gap between the outer surface of the first electrode and the inner surface of the hollow cavity, and penetrating into the anode cavity said predetermined distance.

21. The device according to Claim 20, wherein said second auxiliary discharge is the Penning discharge with hollow cathode.

22. The device according to Claim 20, wherein the dimension of said gap is such as to allow plasma penetration into the hollow cavity, the second auxiliary discharge thereby being the Penning discharge with hollow cathode.

23. The device according to Claim 22, wherein said gap dimension is 2mm or more.

24. The device according to Claim 20, wherein the dimension of said gap is such as to prevent plasma penetration into the hollow cavity, the second auxiliary discharge thereby being the Penning discharge.

25. The device according to Claim 24, wherein said gap dimension substantially does not exceed 2mm.

26. The device according to Claim 20, and also comprising a plate located above the anode and being made with an opening of a cross-section slightly larger than the cross-section of the self-heating electrode, which electrode passes through said opening in the plate.

27. The device according to Claim 26, wherein said second auxiliary discharge is the Penning discharge.

28. The device according to Claim 27, wherein the cross-section of said opening is larger than that of the self-heating electrode on about 0.2-0.6mm.

29. The device according to Claim 27, wherein said hollow cavity provides heat insulation of the self-heating electrode.

30. The device according to Claim 13, wherein the self-heating electrode is at least partly thermo-insulated.

31. The device according to Claim 13, wherein the self-heating electrode is made of at least one refractory metal or doped refractory metal with a reduced work function.

32. The device according to Claim 13, wherein said magnetic field source comprises a ring-like magnet surrounding the cylindrical anode.

33. The device according to Claim 13, wherein the at least one emitting aperture is located at the axis of the electrodes' arrangement.

34. The device according to Claim 13, wherein more than one emitting apertures are provided being formed by openings in the second reflective electrode.

35. The device according to Claim 34, wherein the emitting apertures are located at different distances from the axis of the electrodes' arrangement.

36. The device according to Claim 34, wherein the emitting apertures are arranged in a circular array being located in a spaced-apart relationship at the same radial distance from the axis of the electrodes' arrangement.

37. The device according to Claim 13, wherein the at least one emitting aperture is formed by at least one opening with inclined walls.

38. The device according to Claim 13, wherein the at least one emitting aperture is thermo-insulated, being made of at least one refractive metal or doped refractive metal with a reduced work function.

39. The device according to Claim 13, and also comprising a charged particles' filter accommodated at the output of the emitting aperture.

40. A source device for producing an intensive flow of atomic or excited particles, the device being connectable to a direct current source and comprising an electrodes' arrangement and a magnetic field source, wherein

- the electrodes' arrangement comprises a cylindrical anode and a multiple-electrode cathode which are axially aligned and define an inter-electrode space for a longitudinal magnetic field region;
- the multiple-electrode cathode includes a first elongated self-heating electrode, a second flat reflective electrode in which at least one opening forming at least one emitting aperture is made, and a third reflective electrode, which is a flat electrode located opposite to said second reflective electrode and comprises an opening, through which the self-heating electrode is inserted into the anode cavity and which serves as an

inlet for at least one molecular gas, the anode being located between the second and third electrodes, and the first electrode being electrically connected to the third electrode, when the device is put in operation;

- the first self-heating elongated electrode is axially aligned with the cylindrical anode and penetrates into the anode cavity at a predetermined distance;
- a butt-end of the first electrode located inside the anode cavity, a part of the surface of the second electrode opposite a butt-end of the first electrode and the cylindrical anode form a cell of a main arc Penning discharge ignitable in at least one zone in the vicinity of said at least one emitting aperture;
- the first electrode and the cylindrical anode form a cell of a first auxiliary discharge, which is a magnetron discharge with heated cathode; and
- the second and third reflective electrodes and the cylindrical anode form a cell of a second auxiliary discharge, which is a Penning discharge.

41. A source device for producing an intensive flow of atomic or excited particles, the device being connectable to a direct current source and comprising an electrodes' arrangement and a magnetic field source, wherein

- the electrodes' arrangement comprises a cylindrical anode and a multiple-electrode cathode which are axially aligned and define an inter-electrode space for a longitudinal magnetic field region;
- the multiple-electrode cathode includes a first elongated self-heating electrode, a second flat reflective electrode in which at least one opening forming at least one emitting aperture is made, and a third reflective electrode, the anode being located between the second and third electrodes, and the first electrode being electrically connected to the third electrode, when the device is put in operation;
- the first self-heating elongated electrode is axially aligned with the cylindrical anode and penetrates into the anode cavity at a predetermined distance, the part of the first electrode located inside the anode cavity

having a hollow cavity of a length equal to or slightly less than the height of the anode cavity;

- a butt-end of the first electrode located inside the anode cavity, a part of the surface of the second electrode opposite a butt-end of the first electrode and the cylindrical anode form a cell of a main arc Penning discharge with the self-heating hollow cathode ignitable in at least one zone in the vicinity of said at least one emitting aperture;
- the first electrode and the cylindrical anode form a cell of a first auxiliary discharge, which is a magnetron discharge with heated cathode; and
- the second and third reflective electrodes and the cylindrical anode form a cell of a second auxiliary discharge, which is a Penning discharge.

42. A source device for producing an intensive flow of atomic or excited particles, the device being connectable to a direct current source and comprising an electrodes' arrangement and a magnetic field source, wherein

- the electrodes' arrangement comprises a cylindrical anode and a multiple-electrode cathode which are axially aligned and define an inter-electrode space for a longitudinal magnetic field region;
- the multiple-electrode cathode includes a first elongated self-heating electrode, a second flat reflective electrode in which at least one opening forming at least one emitting aperture is made, and a third reflective electrode, the anode being located between the second and third electrodes, and the first electrode being connected to the third electrode, when the device is put in operation;
- the first self-heating elongated electrode is axially aligned with the cylindrical anode and penetrates into the anode cavity at a predetermined distance;
- the third electrode has a hollow cavity located above said anode cavity, said first electrode extending along the axis of the hollow cavity thereinside with a gap between the outer surface of the first electrode and the inner surface of the hollow cavity;

- a butt-end of the first electrode located inside the anode cavity, a part of the surface of the second electrode opposite a butt-end of the first electrode and the cylindrical anode form a cell of a main arc Penning discharge ignitable in at least one zone in the vicinity of said at least one emitting aperture;
- the first electrode and the cylindrical anode form a cell of a first auxiliary discharge, which is a magnetron discharge with heated cathode; and
- the second and third reflective electrodes and the cylindrical anode form a cell of a second auxiliary discharge, which a Penning discharge with hollow cathode.

43. A source device for producing an intensive flow of atomic or excited particles, the device being connectable to a direct current source and comprising an electrodes' arrangement and a magnetic field source, wherein

- the electrodes' arrangement comprises a cylindrical anode and a multiple-electrode cathode which are axially aligned and define an inter-electrode space for a longitudinal magnetic field region;
- the multiple-electrode cathode includes a first elongated self-heating electrode, a second flat reflective electrode in which at least one opening forming at least one emitting aperture is made, and a third reflective electrode, the anode being located between the second and third electrodes, and the first electrode being connected to the third electrode, when the device is put in operation;
- the first self-heating elongated electrode is axially aligned with the cylindrical anode and penetrates into the anode cavity at a predetermined distance, the first self-heating electrode passing through an opening made in a plate located above the anode, said opening having a cross-section equal to or slightly larger than the cross section of the first electrode;
- the third electrode has a hollow cavity located above said anode cavity, said first electrode extending along the axis of the hollow cavity thereinside

with a gap between the outer surface of the first electrode and the inner surface of the hollow cavity;

- a butt-end of the first electrode located inside the anode cavity, a part of the surface of the second electrode opposite a butt-end of the first electrode and the cylindrical anode form a cell of a main arc Penning discharge ignitable in at least one zone in the vicinity of said at least one emitting aperture;
- the first electrode and the cylindrical anode form a cell of a first auxiliary discharge, which is a magnetron discharge with heated cathode; and
- the second and third reflective electrodes and the cylindrical anode form a cell of a second auxiliary discharge, which is a Penning discharge.